



**UNIVERSITI PUTRA MALAYSIA**

**SYSTEMATIC APPROACH IN PRECISION FERTILIZER  
MANAGEMENT FOR HIGH YIELD RICE PRODUCTION IN THE  
GRANARY AREAS OF PENINSULAR MALAYSIA**

**ABDUL RAZAK HAMZAH.**

**FP 2005 14**

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**By**

**ABDUL RAZAK HAMZAH**

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Degree of Doctor of Philosophy**

**September 2005**



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fulfilment of the requirement for the degree of Doctor of Philosophy

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**Chairman : Associate Professor Mohd Fauzi Ramlan, PhD**

**Faculty : Agriculture**

The National Agriculture Policy 3 (NAP3) clearly stated that national-average rice yield of 7.0 t/ha has to be achieved in order to fulfill self-sufficiency level of 65% by 2010. Recently, the set yield target was revised to 10.0 t/ha by the Ministry of Agriculture and Agro-based Industry (MOA). It is a well-known fact that fertilizer is one of the major inputs required to achieve good crop performance and high yield production. Emphasis is given to the granary areas where there is a higher potential to achieve the set yield target. The aim of this study is to develop systematic approaches in location-specific fertilizer management for high-yield rice production within the granary areas.

In order to satisfy the main objective of this study, two types of data namely primary and secondary data were collected, gathered, and compiled. Primary data

was gathered from experimental studies that were conducted throughout granary areas. The data was analyzed and used to develop location-specific fertilizer management technology package, as well as for package verification studies. Secondary data was compiled from soil survey report and used to run the package for estimating fertilizer recommendation rate on large-scale operational basis. It was also used to estimate location-specific potential yield and to set practical yield target for various locations.

The radiation potential yield of variety MR219 of granary areas was estimated using Rice Supply and Demand Analysis (RSDA) model. Based on the potential yield performance, the granary areas were broadly grouped into three cropping zones namely Northeastern, Northwestern, and Central Western Zones. Attainable yield as affected by radiation level and indigenous soil fertility status was estimated using Crop-Environment Resource Synthesis (CERES) Rice model. Variation of attainable yield is markedly represented by the Northeastern Zone that covers three granaries namely Kemubu Irrigation Scheme (KADA), Kemasin-Semerak Irrigation Scheme, and Besut Irrigation Scheme (KETARA). Thus in this study the Northeastern cropping zone was chosen to develop the attainable yield map.

In modern farming where managers are exposed to advance technology and up to date facilities, location-specific computerized fertilizer recommendation tool can be handled easily. Development of computerized fertilizer-management technology tool (FERTO) for location-specific fertilizer recommendation was able

to assist managers to improve crop yield performance and achieve set high-yield target. Verification result shows model under estimated of set yield target (10 t/ha) of about 9%. The package was also used to estimate the amount of fertilizer required by all granaries for two cropping seasons. Benefit cost ratio of about 2:1 for the package could be achieved as compared to subsidy fertilizer of about 1.5:1 only. However, generalization and simplification of the detail information for policy formulation is necessary. Using this approach, 14 reliable fertilizer management zones were identified. This information is useful in developing revised subsidy fertilizer scheme in order to achieve the set national average yield target of 7 t/ha.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**PENDEKATAN SISTEMATIK DALAM PENGURUSAN PEMBAJAJAN  
PERSIST UNTUK PENGELUARAN HASIL TINGGI PADI DI KAWASAN  
JELAPANG SEMENANJUNG MALAYSIA**

Oleh

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Dasar Pertanian Negara Ke-3 (DPN3) jelas menyatakan purata hasil padi 7 t/ha perlu dicapai bagi memenuhi tahap saradiri negara sebanyak 65% pada tahun 2010. Terkini, Kementerian Pertanian dan Industri Asas Tani telah mengkaji semula sasaran hasil dan menetapkan pada tahap 10 t/ha. Fakta yang diketahui umum, bahawa baja adalah input utama bagi meningkatkan kualiti tanaman dan pengeluaran hasil tinggi. Penekanan dibuat ke atas kawasan jelapang yang berpotensi mencapai sasaran hasil tinggi. Objektif kajian ini adalah untuk membangun satu pendekatan yang sistematik dalam teknologi pengurusan pembajaan di lokasi spesifik untuk pengeluaran hasil tinggi padi di kawasan jelapang.

Untuk memenuhi objektif utama kajian ini, dua jenis data yang terdiri dari data primer dan data sekunder telah dikutip, dikumpul dan disusun. Data primer diperolehi dari kajian yang dijalankan di kawasan jelapang. Data ini dianalisis dan digunakan untuk membangunkan pakej teknologi pengurusan pembajaan di lokasi spesifik dan menentusahkan pakej tersebut. Data sekunder pula dikumpul dari laporan penilaian tanah, dan digunakan untuk menjalankan pakej bagi menentukan kadar pembajaan dalam operasi perladangan berskala besar. Ia juga digunakan untuk menganggarkan potensi hasil di lokasi spesifik dan menentukan sasaran hasil yang praktikal diberbagai lokasi.

Potensi hasil radiasi varieti MR219 untuk kawasan jelapang telah dianggarkan menggunakan Model RSDA. Berdasarkan potensi pencapaian hasil tersebut, kawasan jelapang telah dibahagikan kepada tiga zon tanaman yang utama iaitu Zon Timur Laut, Zon Barat Laut dan Zon Tengah. Hasil yang mampu dicapai dipengaruhi oleh kadar radiasi solar dan status kesuburan tanah, telah dianggarkan menggunakan model CERES-Rice. Perubahan yang besar hasil yang mampu dicapai ditunjukkan di Zon Timur Laut yang meliputi tiga kawasan jelapang iaitu Skim Pengairan Kemubu (KADA), Skim Pengairan Kemasin-Semerak dan Skim Pengairan Besut (KETARA). Oleh itu Zon Timur Laut telah dipilih untuk diplotkan sebagai mewakili peta hasil mampu-capai.

Dalam bidang pertanian moden di mana pengurus ladang sentiasa didedahkan dengan teknologi moden dan peralatan terkini, peralatan berkomputer untuk syor penggunaan baja di lokasi spesifik berupaya dikendalikan dengan mudah dan

berkesan. Pembentukan teknologi perisian pengurusan baja (FERTO) bagi syor pembajaan di lokasi spesifik telah membantu pengurus ladang meningkatkan pencapaian hasil ke arah sasaran hasil yang ditetapkan. Keputusan verifikasi menunjukkan perbezaan pencapaian hasil yang ditetapkan oleh model berbanding hasil sebenar di ladang adalah lebih rendah iaitu pada tahap 9%. Pakej FERTO turut digunakan untuk menganggarkan jumlah baja yang diperlukan oleh semua kawasan jelapang pada dua musim menanam. Nisbah faedah:kos pada kadar 2:1, mampu dicapai oleh pakej FERTO berbanding dengan 1.5:1 sahaja dengan baja subsidi. Walau bagaimanapun, maklumat yang lengkap perlu diambilkira secara umum dan ringkas dalam pembentukan polisi. Melalui pendekatan ini 14 zon pengurusan pembajaan telah dikenalpasti. Maklumat ini berguna untuk merangka satu kajian semula terhadap skim baja subsidi bagi menyokong petani mencapai sasaran purata hasil negara iaitu 7 t/ha.



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I certify that an Examination Committee met on 7<sup>th</sup> September 2005 to conduct the final examination of Abdul Razak Hamzah on his Doctor of Philosophy thesis entitled "Systematic Approach in Precision Fertilizer Management for High Yield Rice Production in the Granary Areas of Peninsular Malaysia" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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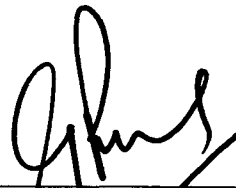
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## **DECLARATION**

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Putra Malaysia or other institutions.

  
**ABDUL RAZAK HAMZAH**

Date: 2<sup>nd</sup> June 2005

## TABLE OF CONTENTS

	<b>ABSTRACT</b>	<b>Page</b>
	<b>ABSTRAK</b>	<b>ii</b>
	<b>ACKNOWLEDGEMENTS</b>	<b>v</b>
	<b>APPROVAL</b>	<b>viii</b>
	<b>DECLARATION</b>	<b>x</b>
	<b>LIST OF TABLES</b>	<b>xii</b>
	<b>LIST OF FIGURES</b>	<b>xviii</b>
	<b>LIST OF ABBREVIATIONS</b>	<b>xx</b>
		<b>xxii</b>
 <b>CHAPTER</b>		
<b>1</b>	<b>INTRODUCTION</b>	<b>1</b>
<b>2</b>	<b>LITERATURE REVIEW</b>	<b>9</b>
	2.1 History and Origin of Rice	9
	2.2 Cultivated Areas	9
	2.3 Production and Consumption	10
	2.4 Botany of Rice	12
	2.5 Physiology of Rice	13
	2.5.1 Vegetative stage	13
	2.5.1.1 Germination	13
	2.5.1.2 Emergence and growth of seedling	13
	2.5.1.3 Tillering stage	14
	2.5.2 Reproductive stage	14
	2.5.2.2 Pollination and fertilization	15
	2.5.2.3 Panicle development	15
	2.5.3 Ripening stage	16
	2.6 Climatic Features of Rice Growing Areas	16
	2.6.1 Radiation	17
	2.6.2 Rainfall	19
	2.6.3 Temperature	22
	2.6.4 Humidity	24
	2.7 Landscape and Soil Characteristic of Rice Growing Areas	24
	2.7.1 Topography	25
	2.7.2 Soil Physico-chemical Characteristics	25
	2.7.2.1 Texture and Structure	26
	2.7.2.2 Soil Depth	27
	2.7.2.3 Fertility Status	28
	2.7.2.4 Cation Exchange Capacity (CEC)	29
	2.7.2.5 Sum of Basic Cation	29
	2.7.2.6 pH Water	29
	2.7.3 Soil Moisture	30
	2.7.4 Nutrient Requirement	31
	2.8 Farming Practices	35
	2.8.1 Land Preparation	36



2.8.2	Water Management	37
2.8.3	Seeding Technique	37
2.8.4	Fertilizer Management	39
2.8.5	Weed Management, and Pest and Disease Control	41
2.8.6	Harvesting and Post-harvest Handling	42
2.9	Crop Growth and Yield Performance Indicators	43
2.9.1	Leaf Development	43
2.9.2	Tiller Development	44
2.9.3	Yield Component Development	45
2.10	Rice Cultivation in Malaysia	45
2.10.1	Granary Areas	46
2.10.2	Single to Double Cropping	48
2.10.3	Transplanting to Direct Seeding	49
2.10.4	Varieties Planted	50
2.10.5	Yield Performance of Granary Areas	51
2.11	Fertilizer Formulation/Recommendation	52
2.11.1	Fallacy of Subsidy Fertilizer Schemes 1 and 2	53
2.11.2	New Fertilizer Formulation for High Yield Performance	55
2.12	NAP3 and MOA Yield Target	55
2.13	DSS for Agricultural Planning in Rice Farming	56
<b>3</b>	<b>GENERAL METHODOLOGY</b>	<b>59</b>
3.1	Database Set-up	59
3.1.1	Biophysical Database	60
3.1.1.1	Climatic Data	60
3.1.1.2	Soil Data	62
3.1.1.3	Designation of Rice Area Suitability	63
3.1.2	Crop Phenology Data	66
3.1.3	Crop Management Data	66
3.1.4	Socio-economic Data	66
3.2	Modeling Approach	67
3.2.1	RSDA Model	67
3.2.2	CERES-Rice Model	67
3.2.3	FERTO Model	68
3.3	Crop Management Practices	68
3.3.1	Crop Setting	69
3.3.2	Crop Care and Maintenance	70
3.3.3	Study Locations and Sampling Procedures	71
3.3.4	Soil Sampling and Analysis	74
3.3.5	Plant Sampling and Foliar Analysis	74
3.3.6	Crop Cutting Test (CCT) and Yield Component Analysis	75

<b>4</b>	<b>MODELING POTENTIAL YIELD OF RICE FOR CROP PLANNING IN GRANARY AREAS</b>	<b>77</b>
	4.1 Introduction	77
	4.2 Materials and Methods	79
	4.2.1 Modeling Approach	79
	4.2.2 Output Analysis	81
	4.2.2.1 Gridded Surfaces Climatic Parameters	81
	4.2.2.2 Potential Yield and Climatic Parameters Trends	81
	4.2.2.3 Cropping Zone and Planting Schedule	82
	4.3 Results and Discussion	82
	4.3.1 Gridded Surfaces Input Model	82
	4.3.1.1 Radiation Pattern	83
	4.3.1.2 Rainfall Pattern	90
	4.3.1.3 Other Climatic Parameters Patterns	91
	4.3.2 Potential for High-yielding Production	91
	4.3.3 Cropping Schedule	96
	4.4 Conclusions	98
<b>5</b>	<b>ESTIMATION PROCEDURE FOR CALCULATING ATTAINABLE RICE YIELD PERFORMANCE</b>	<b>101</b>
	5.1 Introduction	101
	5.2 Materials and Methods	102
	5.2.1 Weather Data	103
	5.2.2 Soil Data	103
	5.2.3 Crop Management Data	105
	5.2.4 Model Predictions of Rice Yields	105
	5.2.5 Soil Grouping, Yield Mapping and Yield Transfer Function	106
	5.3 Results and Discussion	106
	5.3.1 Potential yield in Relation to Weather Pattern and Soil Type	106
	5.3.2 Rational of Using Potential Yield Y80	110
	5.3.3 Soil Grouping Based on Potential Yield	111
	5.3.4 Yield Mapping Based on Potential Yield	113
	5.3.5 Yield Transfer Function Based on Total Solar Radiation	115
	5.5 Conclusions	118
<b>6</b>	<b>DEVELOPMENT OF COMPUTERIZED FERTILIZER MANAGEMENT TECHNOLOGY FOR HIGH-YIELDING RICE PRODUCTION</b>	<b>119</b>
	6.1 Introduction	119
	6.2 Materials and Methods	121
	6.2.1 Concept for FERTO Model Development	121
	6.2.1.1 Input Data	121
	6.2.1.2 Knowledge Base	122
	6.2.2 Model Development	130
	6.2.3 FERTO verification	131
	6.3 Results and Discussion	132



6.3.1 FERTO Desktop Test Run	132
6.3.2 Computerized generation of Location-specific Recommendation	136
6.3.2.1 Soil-specific Fertilizer Recommendation	136
6.3.2.2 Recommendation for Up-scaling Verification	138
6.3.2.3 Recommendation for Detail Verification	143
6.3.3 FERTO Field Verification	143
6.3.3.1 Yield Performance Indicator of Up-scaling Verification	145
6.3.3.2 Yield Component Analysis of Detail Verification	146
6.3.3.3 Set Yield Target versus Actual Yield Performance	150
6.4 Conclusions	155
<b>7 EFFECTIVE FERTILIZER MANAGEMENT FOR HIGH YIELD PERFORMANCE OF RICE</b>	<b>157</b>
7.1 Introduction	157
7.2 Materials and Methods	158
7.2.1 Up-scaling Model Verification	158
7.2.2 Mapping of Fertilizer Recommendation for Granary Areas	160
7.2.3 Development of Fertilizer Management Zone	160
7.3 Results and Discussion	161
7.3.1 Location Specific Fertilizer Recommendation	161
7.3.2 Large-scale Yield Performance	163
7.3.3 Spatial Fertilizer Recommendation	170
7.3.4 Fertilizer Management Zone	171
7.4 Conclusions	173
<b>8 ECONOMIC ANALYSIS OF HIGH-YIELDING RICE PRODUCTION THROUGH FERTILIZER MANAGEMENT PACKAGE ADOPTION</b>	<b>175</b>
8.1 Introduction	175
8.2 Materials and Methods	177
8.2.1 Production Status and Self-sufficiency Level	177
8.2.2 Site-specific Fertilizer Recommendation	177
8.2.3 Soil Series of the Granary Areas	178
8.2.4 Fertilizer Input Cost	178
8.3 Results and Discussion	178
8.3.1 FERTO Adoption and Self-sufficiency Level	178
8.3.2 Managing FERTO Fertilizer Application	181
8.3.3 Soil Series Delineation in the Granary Areas	183
8.3.4 Fertilizer Requirement for Set High Yield Target	186
8.3.5 FERTO, Fertilizer Costs and Socio-economic Benefits	189
8.4 Conclusions	191

<b>9</b>	<b>GENERAL DISCUSSION AND RECOMMENDATIONS</b>	<b>194</b>
9.1	Introduction	194
9.2	Paradigm Shift in Fertilizer Management for High Yield Production	195
9.2.1	Basic Principle 1: Nutrient Quantity	196
9.2.2	Basic Principle 2: Nutrient Access	197
9.2.3	Basic Principle 3: Balance Crop Nutrient Requirement	198
9.2.4	Basic Principle 4: Indigenous Soil Nutrient Status	199
9.3	Enhancing Effectiveness of FERTO	200
9.3.1	Cropping Schedule	200
9.3.2	Crop Setting	202
9.3.3	Varietal Choice	203
9.3.4	Social Status of Farmers	204
9.4	Benefits of FERTO	205
9.4.1	Economic Impact	206
9.4.2	Policy Decisions	206
9.5	Rice Industry and National Agriculture Plan	208
9.6	Conclusions and Recommendations	209
9.6.1	R & D Approaches in Fertilizer Management Technology	210
9.6.2	R & D Approaches in Soil Fertility Degradation	211
9.6.3	R&D Approaches in Precision Fertilizer Management	212
9.6.4	Nutrient Mapping for Variable Nutrient Ratio	213
	<b>BIBLIOGRAPHY</b>	<b>214</b>
	<b>APPENDICES</b>	<b>227</b>
	<b>BIODATA OF THE AUTHOR</b>	<b>229</b>

## LIST OF TABLES

Table	page
2.1 Production of rice, cultivated area, country level yields, imports and exports, and total domestic consumption in 2001 for the Asia countries	11
3.1 Steps used in the estimation of percolation rate and indigenous soil nutrient status	64
3.2 Crop management practices for variety MR219	72
3.3 Methodology of analysing soil physical-chemical properties	76
3.4 Methodology of analysing crop sample	76
4.1 Crop phenological data used by RSDA Model as genetic coefficient for MR219	80
4.2 Average potential yields of rice for granary areas of Peninsular Malaysia	94
5.1 Total solar radiation of various zones in relation to planting season	104
5.2 Rice production on various soil types in relation to climatic zone and planting season	108
5.3 Constants of the rice yield transfer function	117
6.1 Formulation of FERTO recommendation	129
6.2 Fertilizer rates based on FERTO recommendation	144
6.3 Rice yield of season 2/2002 in Tanjung Karang MARDI Station	147
6.4 Rice yield of season 2/2002 at farmer's plot in Pasir Panjang	147
6.5 Yield performance by FERTO recommendation and subsidy fertilizer at various cropping zones	151
7.1 Major soil series planted with rice in the granary areas	162
7.2 FERTO and farmer fertilizer rates used in the study locations	162
7.3 Split applications of FERTO fertilizer recommendation rate	164
7.4 Yield performance based on FERTO and farmer fertilizer rates	164

7.5	Fertilizer recommendation zones by FERTO for high yield performance of rice crop	172
8.1	Self-sufficiency level based on adoption of FERTO technology by granaries at set yield target	179
8.2	FERTO recommendation rate (kg/ha) based on soil type at set high yield target	182
8.3	Hectarage of soil types used for rice cropping in granary areas	184
8.4	Required fertilizer amount (kg) based on set yield target in granary areas	188
8.5	Required fertilizer amount (kg) based on 30 % adoption of FERTO technology by granaries	188
8.6	Average required fertilizer (kg/ha) for set yield target in granary areas	188
8.7	Fertilizer cost (RM/year) for granaries at set yield target	190
8.8	Fertilizer cost (RM/year) for 30% adoption levels of FERTO technology at set yield target	190
8.9	Benefit:cost ratio based on FERTO and subsidy fertilizer recommendation options	191

## LIST OF FIGURES

Figure		Page
3.1	Process of interpolation from point base climatic data into a spatial layer	61
3.2	Processes to prepare digital maps	65
4.1a	Solar radiation (MJ/m <sup>2</sup> /day) pattern of lowland areas in Peninsular	84
4.1b	Temperature (°C) pattern of lowland areas in Peninsular	85
4.1c	Rainfall (mm/month) pattern of lowland areas in Peninsular	86
4.1d	Rainy-days (no. of day per month) pattern of lowland areas in Peninsular	87
4.1e	Wind speed (m/s) pattern of lowland areas in Peninsular	88
4.1f	Evaporation (mm) pattern of lowland areas in Peninsular	89
4.2a	Potential yield (t/ha) in granaries based on biweekly planting time from January to June	92
4.2b	Potential yield (t/ha) in granaries based on biweekly planting time from July to December	93
4.3	Cropping zone based on solar radiation pattern	95
4.4	Cropping schedule for various cropping zones	99
5.1	Soil grouping of various zones based on yield range of rice	112
5.2	Yield map of rice for Kelantan plain	114
6.1	A basic concept for FERTO package development.	123
6.2	Estimated CEC status in relation to soil-yield carrying capacity	128
6.3	Status of yield performance versus DRIS Index of various nutrient elements	128
6.4	Introduction window of FERTO package	134
6.5	Data input window of FERTO package	134
6.6	Fertilizer recommendation window of FERTO package	135
6.7	Fertilizer management window of FERTO package	135

6.8	Production cost window of FERTO package	137
6.9	Revenue window of FERTO package	137
6.10	Nitrogen fertilizer required for set high yield target in Peninsular	139
6.11	Phosphorus fertilizer required for set high yield target in Peninsular	140
6.12	Potassium fertilizer required for set high yield target in Peninsular	141
6.13	Chicken manure based fertilizer required for set high yield target in Peninsular	142
6.14	Discrepancy of targeted and actual yields from two experimental plots	153
6.15	Sensitivity analysis of fertilizer recommendation rate by FERTO model based on different set yield target and soil fertility status	154
7.1	Nitrogen fertilizer rate (kg/ha) for high yield performance of rice in the granary areas	166
7.2	Phosphorus fertilizer rate (kg/ha) for high yield performance of rice in the granary areas	167
7.3	Potassium fertilizer rate (kg/ha) for high yield performance of rice in the granary areas	168
7.4	Chicken manure rate (kg/ha) for high yield performance of rice in the granary areas	169

## **LIST OF ABBREVIATIONS**

<b>Al</b>	<b>Aluminium</b>
<b>B</b>	<b>Boron</b>
<b>Ca</b>	<b>Calcium</b>
<b>CCT</b>	<b>Crop Cutting Test</b>
<b>CEC</b>	<b>Cation Exchange Capacity</b>
<b>CERES</b>	<b>Crop Environment Resource Synthesis</b>
<b>CM</b>	<b>Chicken Manure</b>
<b>CSI</b>	<b>Crop Season I</b>
<b>CSII</b>	<b>Crop Season II</b>
<b>Cu</b>	<b>Copper</b>
<b>DAS</b>	<b>Day After Seeding</b>
<b>DEM</b>	<b>Digital Elevation Model</b>
<b>DOA</b>	<b>Department of Agriculture</b>
<b>DRIS</b>	<b>Diagnosis and Recommendation Integrated System</b>
<b>DSS</b>	<b>Decision Support System</b>
<b>EDP</b>	<b>Electronic Data Processing</b>
<b>ESNM</b>	<b>Expert System of Nutrient Management</b>
<b>FAO</b>	<b>Food and Agriculture Organization</b>
<b>Fe</b>	<b>Iron</b>
<b>FELCRA</b>	<b>Federal Land Consolidation and Rehabilitation Authority</b>
<b>FERTO</b>	<b>Fertilizer Management Technology Tool</b>
<b>GDP</b>	<b>Gross Domestic Product</b>
<b>GIS</b>	<b>Geographic Information System</b>

HYV	High Yielding Variety
IADP	Integrated Agriculture Development Project
IBSNAT	International Benchmark Sites Networking for Agrotechnology Transfer
ICT	Information and Communication Technology
IRRI	International Rice Research Institute
IT	Information Technology
K	Potassium
KADA	Kemubu Agriculture Development Authority
KETARA	'Projek Kemajuan Terengganu Utara'
LAI	Leaf Area Index
MADA	Muda Agriculture Development Authority
MARDI	Malaysian Agricultural Research and Development Institute
MDS	Minimum Data Set
Mg	Magnesium
MIS	Management Information Systems
MMS	Malaysian Meteorological Services Department
Mn	Manganese
MOA	Ministry of Agriculture
MOP	Muriate of Potash
N	Nitrogen
NAP3	National Agriculture Policy 3
P	Phosphorus
PBLS	'Projek Barat Laut Selangor'



R&D	Research and Development
RMSE	Root Mean Square Error
RSDA	Rice Supply and Demand Analysis model
RYSTPAP	Rice Yield Estimation for Potential and Attainable Production model
S	Sulfur
SSL	Self-sufficiency Level
TSP	Triple Super Phosphate
VNR	Variable Nutrient Ratio
WTO	World Trade Organization
Y80	Yield at 80% chance to happen
Yn	Nutrient-limited Yield
Yp	Potential Yield
Ys	Simulated Yield
Yw	Water-limited Yield
Zn	Zinc